MPERVIOUS CUTOFF

by means of

SLURRY TRENCH CONSTRUCTION

MILL SITE DAM AND RESERVOIR
FERRON CREEK
FERRON, UTAH

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
1972

MILL SITE DAM AND RESERVOIR

FERRON CREEK

FERRON, UTAH

IMPERVIOUS CUTOFF

BY MEANS OF

SLURRY TRENCH

CONSTRUCTION

SOIL CONSERVATION SERVICE

Prepared by
Joseph E. Hanson
Project Engineer

Assisted by:
Craig Johansen, Asst. Project Engineer
Jack Stevenson, Soil Mechanics Engineer, Portland, Ore.
William P. Ogden, Utah State Construction Engineer
Scott B. Passey, SCS Area Conservationist

MILL SITE DAM SLURRY TRENCH CONSTRUCTION

FERRON WATERSHED NEAR FERRON, UTAH

1. Abstract:

2. Purpose of Report:

3. Project Data:

   a. Location
   b. Description of Dam
   c. Purpose of Slurry Trench

4. Explorations:

   a. Purpose
   b. Method
   c. Conclusion

5. Construction of Slurry Trench:

   a. Method
   b. Equipment
   c. Slurry
   d. Backfill
   e. Zone I Embankment Over Slurry Trench

6. Methods of Testing:

   a. Slurry Requirements
   b. Slurry Testing
   c. Backfill

7. Measurement and Payment:

   a. Contract
   b. Measurement

8. Recommendations for Future Work

Chart: Weight of Slurry vs. Critical Depth of Trench

Specification

Drawings

   a. Cross Section of Dam
   b. Layout of Cutoff Trench
   c. Profile of Cutoff Trench
   d. Profile of Slurry Trench
   e. Actual Profile of Slurry Trench after Excavation

Pictures

1. ABSTRACT: An impervious barrier was constructed using the slurry trench process as part of the seepage control measures for the Mill Site Dam. This barrier was 900 feet long with a maximum depth below original ground level of 110 feet. It was excavated through alluvial gravel deposits containing some strata of sandy silts. Preconstruction investigations indicated the gravel strata were interconnected and moderately to highly pervious.

The slurry trench was excavated with a Lima dragline. A combination of steep narrow channels in the bedrock, the very compact gravels and the size of excavating equipment resulted in excavation difficulties.

2. PURPOSE OF REPORT:

a. Location: Mill Site Dam is located on Ferron Creek approximately 3 miles west of Ferron City and 12 miles upstream from its confluence with the San Rafael River, a tributary of the Colorado River. This is a multiple purpose project developed for irrigation water storage, with additional benefits assigned to flood prevention, sediment storage and recreation. Ferron City has a population of 360. There are 350 people living outside of the city who will benefit from the project. Reservoir water will be used for supplemental irrigation on presently cultivated lands.

b. Description of the Dam: Mill Site Dam consists of an earth fill dam, concrete outlet conduit and spillway. The dam is 3800 feet long, with maximum height of 120 feet and top width of 26 feet.

Maximum depth to bedrock after foundation excavation was 80 feet. To complete the dam required 40,000 cubic yards of foundation excavation, 50,000 cubic yards of cutoff trench excavation, 2,500,000 cubic yards of compacted fill, 4,000 cubic yards of concrete in the emergency spillway and outlet works. The reservoir covers 480 acres when full. There is 2000 acre feet of storage for recreation, 5000 acre feet for sediment retention and 12,000 acre feet for irrigation.

c. Geology of the Site: The damsite is located in the Colorado Plateau Physiographic Province on the border between the Wasatch Plateau and Castle Valley subdivisions. Ferron Creek in the vicinity of the site is a relatively narrow canyon with a floodplain 800 feet wide. The canyon has been cut by the stream into the formations of the Wasatch Plateau. Immediately below the damsite the stream emerges from the canyon and enters into the broad open agricultural area of Castle Valley.

Castle Valley owes its existence to the relative softness of the thick Mancos formation which underlies it. In this area, the Mancos dips gently northwestward under the Wasatch Plateau. The strike of the beds in the vicinity of the dam is generally N45° E, dip 5° NW. Bedrock at the site is in the Emery member of the Mancos formation and is Cretaceous in age.

d. Purpose of Slurry Trench: Plans and specifications for Mill Site Dam required construction of a slurry trench between cutoff stations 18+40 and 27+40 (See cross-section of dam, Fig. No. 1) to provide seepage control in deep pervious alluvium. Foundation materials over bedrock consist of 8 to 10 feet of organic sandy silt overlying stream-deposited sandy gravel 15 feet to 80 feet deep. The water table was at ground level, or approximately 10 feet above the top of the proposed slurry trench, when construction began.

4. EXPLORATION

a. Purpose: To determine bedrock depth along slurry trench and type of materials in the alluvium. The data collected in the design investigation was supplemented with the following work as the design progressed.

b. Methods: A contract was let for a rotary drill and a cable-tool drill. Each rig drilled alternate holes at 50 foot intervals across the valley floor along the proposed slurry trench centerline. The cable-tool drill took continuous 6-inch "drive" samples to bedrock. The rotary drill used a "split spoon" and recovered samples at 5-foot intervals.

The "drive"sample tubes were 6 inches in diameter and 2.5 feet long. They were cut from standard weight seamless steel casing. A "bead" was welded inside the tube near the bottom to aid in retaining samples. Vent holes were cut at intervals along the sides of the tubes to permit water release and prevent mixing of the sample as it was removed from the tube.

Most of the cobble in the alluvium were small enough to enter the tubes and less disturbance of the sample resulted from driving with long-stroke "fishing jars". Materials were removed from the sampler and placed on a plywood board for classification, logging and photography, (See photos 1 and 2).

The rotary drill was used to obtain 1.5 inch "drive" samples of the alluvium and cores of the bedrock. Coring was continued until sound rock was penetrated.

The rotary drill was much faster than the cable-tool drill, mainly because of less moving and "set-up" time. The cable-tool drill also had more non-productive time due to lost or lodged tools in the holes

c. Results: A profile of the bedrock location was prepared and used as a guide in excavation of the slurry trench. This profile is shown on Figure 3. A channel or canyon in the bedrock with steep sides running perpendicular to the center-line of the slurry trench exists between station 23+20 and station 24+60. Another such canyon occurs between station 20+20 and station 22+30. See Figure (3) and (4) for details. Actual probing in the trench corresponded favorably with the bedrock profile. Materials excavated from the slurry trench were identical to those obtained from the drill samplers.

5. CONSTRUCTION OF SLURRY TRENCH:

a. Method: The water table was lowered 20 feet by pumping from

sumps in excavated trenches. This was 10 feet below the designed top elevation of the slurry trench. The 8 to 10 feet of organic sandy silt materials was removed from the base area of the dam. Then a trench 5 feet deep, with a bottom width of 20 feet and 2:1 side slopes was constructed for the full length of the slurry trench. The trench was back-filled with compacted Zone I material. This provided a bond with the completed slurry trench and the dam. It also provided a suitable foundation for equipment operation. A slurry trench 8 feet wide was then excavated to bedrock through the Zone I backfill. The vertical sides were supported by slurry, which was maintained at a minimum of 3 feet below the top of the trench, (See photos 4 and 5). Ground water level was kept between 5 and 10 feet below the top of the slurry trench.

Dragline excavation of the trench began on August 12, 1969, at station 27+40. Difficulties were encountered between stations 24+00 and 23+40 when the equipment was unable to remove materials to the required depth. Excavation difficulties were caused by narrowness of the bedrock channel (See figure 3), and the lightness of the dragline bucket. The only excavation equipment at the site was the dragline. At a later date weights were added to the bucket and a drag ripper was obtained, (See Phote 6). On September 9, 1969, the sub-contractor decided to move on, maintaining the material could not be excavated to bedrock by a dragline.

A "port-a-drill" was brought onto the site, holes were drilled directly in the bottom of the trench at station 23+80 in an attempt to prove the material was bedrock. Drilling revealed a 6-foot layer of small boulders and gravel underlain by a soft silty gravel. An air pump was fitted with three 6" teeth and used as a dredge. This operation resulted in 8 or 9 "post-holes" in the bottom of the trench, extending to a depth of about 55 feet below the surface. Excavation with a clamshell bucket was attempted with no appreciable success. When efforts failed with these pieces of equipment, this portion of the trench was backfilled.

Excavation progressed smoothly from station 23+40 to 22+00 where depth to bedrock ranged from 20 to 30 feet. Between stations 22+00 and 21+00, excavation progress became very slow below 30 feet due to cemented and highly compacted materials.

A drag ripper was brought on the site and rigged onto the dragline. Excavation advanced to a depth of 65 feet by using the ripper and bucket alternately. At this depth progress became slow and the contractor requested permission to use blasting powder. Two charges were placed directly on the bottom of the trench with heavy cast iron weights placed over the powder. One charge consisted of 11 sticks of 1/4 pound each of 70% powder and the other 8 sticks of the same powder. The resulting blasts shook the trench walls violently and left cracks in the banks, however, there was very little caving, (See photo 9).

An air track-drill was brought onto the site and holes were drilled in the bottom of the trench on October 14, 1969. These holes were loaded with 5 to 8 sticks of 40% powder and the charges were set off. After blasting the contractor excavated to bedrock by alternating use of the ripper and the dragline bucket. Rate of excavation progress was about the same after blasting as before. A depth of 77 feet was reached between stations 21+00 and 20+60.

Excavation progressed without further difficulty until the rock contact was followed to the surface on the left abutment, at station 18+20. In order to excavate the last 100 feet, the dragline was set on the left abutment about 40 feet above the level of the slurry trench. Excavation of this portion of the trench was completed on November 7, 1969.

On October 21, a rotary drill was brought on the site to core-drill in three locations along the slurry trench between stations 24+00 and 23+70. This drill cored between depths of 40 to 50 feet in an attempt to identify the materials. Samples showed cores of small boulders and assorted sizes of gravel. No matrix or cemented material was recovered.

Re-excavation of the slurry trench between stations 23+40 and 24+00 began on November 18, 1969, (See photo 13). By alternating use of the ripper (which was not on the site when initial excavation was made), and the dragline bucket, a depth of 53 feet was reached, at which point the contractor requested

permission to blast. Permission was granted after a discussion with him in which it was pointed out that he was making greater progress now than after blasting in the 21+00 to 22+00 area. After blasting the trench was excavated to a depth of 57 feet with progress being slower than it was before blasting. On December 1, 1969 the dragline was pulled off the site and the remainder of the cleaning was done by the air lift pump. On December 5, 1969 the slurry trench was completed.

b. Equipment: Excavation of the slurry trench was accomplished by using a Lima Dragline with a boom length of 120 feet, (see photo 1). A five cubic yard bucket was fitted with side-cutters to obtain the specified eight-foot width of trench, (see photo 7). The bucket was weighted to an estimated 14 tons by adding steel plates to the sides and bottom.

A drag-type ripper was modified and used to loosen the cemented materials during excavation at depths below forty feet, (see photo 6). A hose from an air compressor was attached to an 8" pipe blow-tube. This acted as a sump pump and was used to clean sand and silt from the bottom of the trench. A 50-ton crane moved the pipe along the slurry trench.

A high volume pressure turbine pump was used to mix the water and bentonite. Two four inch pumps moved the slurry through plastic lines for use in the trench, backfill and in de-sanding operations.

Backfill material was prepared by mixing Zone I fill material with slurry from the trench. A D-8 dozer mixed the

material along side the trench, (see photo 11). A B-22 dragline with a clamshell placed backfill until the specified 7 to 1 slope was obtained. At this point a D-8 dozer pushed backfill material into the trench as it was mixed,(see photo 12).

c. Slurry: The slurry consisted of Wyoming Sodium Bentonite mixed with water to a density of 65 pounds per cubic foot. Density of the slurry increased to 85 pounds per cubic foot as construction proceeded. At this density the slurry was pumped through a centrifugal desander, (see photo 10). This procedure maintained slurry density below 85 pounds per cubic foot (contract specifications modified from 75 to 85 pounds). Viscosity, as measured by a Marsh Funnel, was maintained greater than 40 seconds. Wyoming Bentonite used to produce the slurry was transported onto the site in bulk. It was run through a special mixing unit, where water was added, and was stored in two reservoirs constructed on the upstream toe of the dam. Approximately 6 percent bentonite by weight was used with water to meet required density.

d. Backfill: Backfill materials consisted of Zone I fill mixed with slurry until a uniform appearance and a slump of 4 to 8 inches was obtained. Zone I fill materials consisted of minus 5 inch well graded gravel containing 25 to 40 percent fines. This material was prepared in a blending plant and placed adjacent to the slurry trench. Slurry was pumped from the trench, sprayed on the Zone I fill material and mixed with a D-8 dozer.

e. Zone I Embankment Over Slurry Trench: Within four hours after completing backfill of the slurry trench it was covered with three feet of uncompacted Zone I backfill. This was allowed to settle from two weeks to two months in which time there was no visible settlement. A dike of Zone I material 12 feet high was then placed over the slurry trench. Pumping equipment used to dry the foundation was then shut down and the de-watering trenches were backfilled with gravel. This was done just prior to winter shut-down. The contractor was informed that seepage through the dike could cause foundation-water problems in the spring.

Settlement and vertical cracking occurred the following spring as fill over the slurry trench thawed out. Principal settlement was between stations 23+40 and 24+00, one of the deep gorges, (see photo 15). There was also a vertical crack along the centerline of the slurry trench, (See photo 14). To remedy this condition Zone I fill material over the slurry trench was removed to within 3 feet of the slurry backfill, (see photo 16). The area over the slurry trench was then rolled to obtain the specified degree of compaction and covered by the required blanketing.

6. METHODS OF TESTING

a. Slurry Requirements: Specified requirements for quality and consistency of slurry were as follows:

(1) Slurry when first mixed:

(a) Density shall not be less than 65 pounds per cubic

foot measured at the point where fresh slurry is discharged into the trench.

(b) Viscosity shall not be less than 40 seconds when measured by the Marsh Funnel.

(c) Water loss shall not be more than 15 cubic centimeters in 30 minutes.

(2) Slurry in the trench at the time of placing backfill:

(a) Density shall not be greater than 85 pounds per cubic foot measured at any depth within the Zone where backfill is to be placed.

(b) Water loss shall not be more than 20 cubic centimeters in 30 minutes.

b. Slurry Testing:

(1) To obtain a sample of slurry being placed in the trench a petcock on the bottom of the pump was opened to fill a container. A slurry trench sampler was made as follows: A 3/4 inch by 4" x 4" plate was welded on the bottom of a 2 inch diameter heavy duty pipe. A 1/4" plate hinged on one side and held tight with a spring on the other side was placed on top of the pipe. A handle was welded to the pipe. A rope was attached to the handle to lower the sampler into the slurry. When the sampler was at the required depth the top was opened by means of a cord attached to it. (A Kemmerer water sampler will serve the same purpose.)

(2) To test for density a sample of the slurry was obtained from the trench. This sample was then placed in a

container of known volume and weighed.

(3) The slurry viscosity was tested using a Marsh Funnel. The Marsh Funnel consists of a funnel of specified volume and opening. The test consists of filling the funnel with slurry and timing its complete discharge.

(4) Water loss of the slurry was determined by using a 3 inch diameter container filled with slurry and placed under 100 p.s.i. pressure. The bottom of this container consisted of a screen over which a filter paper was placed. Water loss from the container was collected and measured. When the test was completed and the filter paper removed it was found to be covered with a cake of bentonite approximately 1/2 inch thick.

c. Backfill: Backfill for the slurry trench was tested with a concrete slump cone. Specifications called for a slump between 4 and 8 inches. It was found that with a slump of 4 inches the backfill would slope in the trench 12 feet horizontal to 1 foot vertical.

7. MEASUREMENT AND PAYMENT

(The following wording was taken from the contract document)

The slurry trench will be measured to the nearest square foot. Area boundaries shall be the top of the slurry trench and the bedrock contact determined by probing the trench bottom at 20 foot intervals along the centerline. The 20 foot intervals will be measured along the top surface of the slurry trench cutoff. Depths to bedrock will be determined immediately before backfilling the trench. The area

for payment will be the sum of areas computed by the average of two adjacent depth measurements multiplied by the distance between the adjacent depth measurements.

Payment will be made at the contract unit price. Such payment will constitute full compensation for all labor, equipment and material required to excavate and backfill the slurry trench as specified, including the equipment and personnel required to make the depth measurement.

8. RECOMMENDATIONS FOR FUTURE WORK

The first consideration must be whether the slurry trench can actually be excavated.

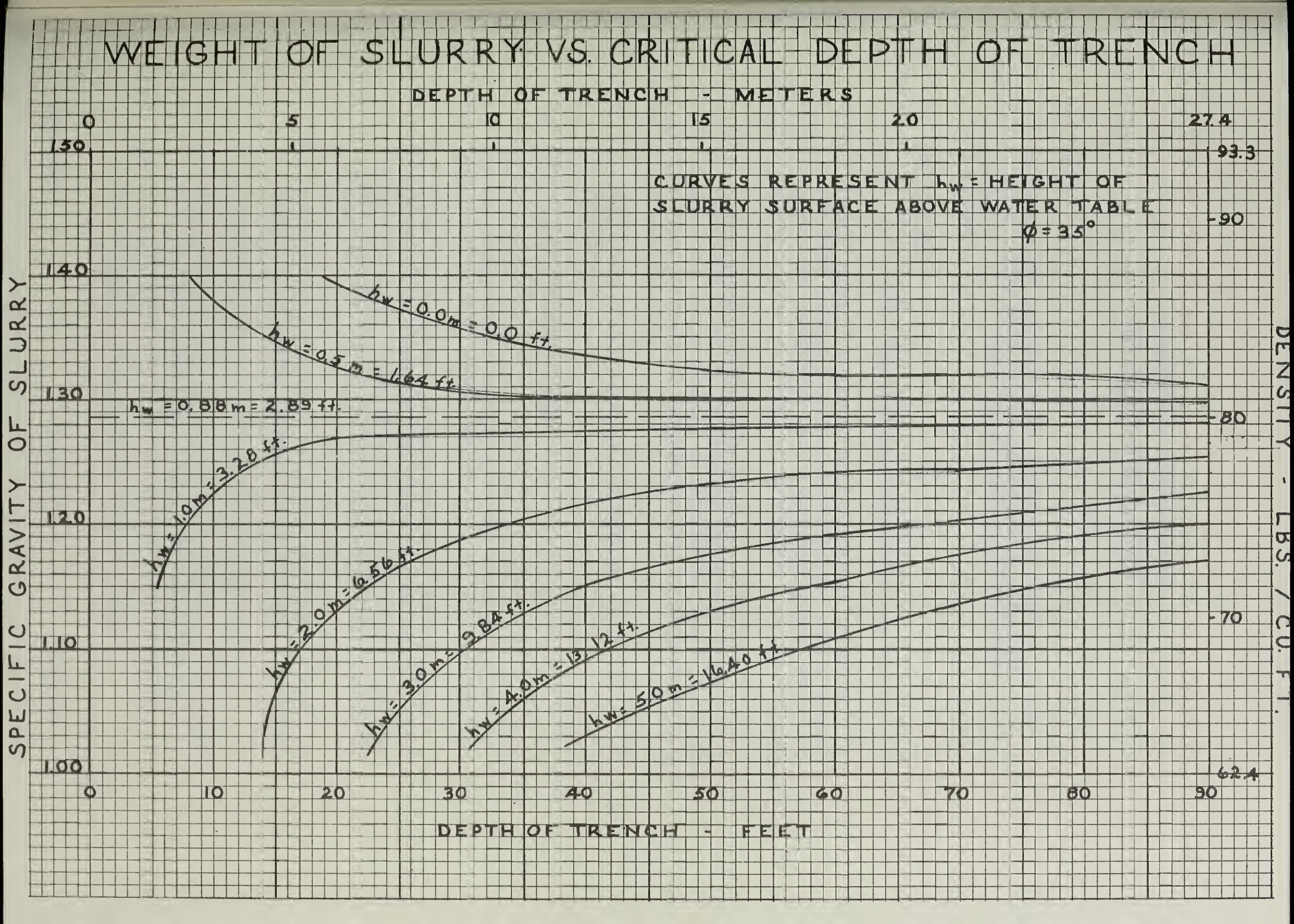
Drill holes should be spaced at maximum 50-foot intervals and should be continuously sampled and logged to required depth.

Observation of the drilling and inspection of samples should be done by the person who will supervise construction of the slurry trench. Comparisons of excavated materials with those logged in the drill holes will help determine depth of the excavation.

Type of equipment needed to excavate the trench should be determined jointly by the design and construction engineers.

The contractor must understand that he will be responsible for providing any additional equipment needed to complete the job. This can be done during the pre-construction meeting. (Example: during excavation of the South gorge (stations 23+40 to 24+00) it was found that the dragline bucket and digging chains were longer than the width of the gorge and excavation could not be completed to bedrock without modification of equipment.)

Settlement of the trench backfill will likely occur, causing vertical cracking in the fill above. Correction of this condition should be anticipated and provided for in the design and specifications.


WEIGHT OF SLURRY VS. CRITICAL DEPTH OF TRENCH
DEPTH OF TRENCH - METERS
0
5
10
15
20
27.4
CURVES REPRESENT h_w = HEIGHT OF SLURRY SURFACE ABOVE WATER TABLE
$\phi = 35°$
$h_w = 0.0\,m = 0.0\,ft.$
$h_w = 0.5\,m = 1.64\,ft.$
$h_w = 0.88\,m = 2.89\,ft.$
$h_w = 1.0\,m = 3.28\,ft.$
$h_w = 2.0\,m = 6.56\,ft.$
$h_w = 3.0\,m = 9.84\,ft.$
$h_w = 4.0\,m = 13.12\,ft.$
$h_w = 5.0\,m = 16.40\,ft.$
SPECIFIC GRAVITY OF SLURRY
1.50
1.40
1.30
1.20
1.10
1.00
DENSITY - LBS. / CU. FT.
93.3
90
80
70
62.4
0
10
20
30
40
50
60
70
80
90
DEPTH OF TRENCH - FEET

The instructions for slurry trench construction shown on the drawings establish the minimum control required during backfill operations to prevent backfill materials from falling uncontrolled down the steep bedrock surfaces. These instructions do not relieve the Contractor of any responsibility as specified above. If the Contractor chooses to begin excavation at the opposite end of the slurry trench cutoff, he shall develop a similar plan of operations for approval by the Contracting Officer.

4. SLURRY

The slurry shall consist of a stable colloidal suspension of bentonite in water. Tests to determine the slurry properties shall be made in accordance with testing procedures described in American Petroleum Institute Recommended Practice 138, November 1962, First Edition, Standard Procedure for Testing Drilling Fluids, issued by American Petroleum Institute, Division of Production, 300 Corrigan Tower Building, Dallas, Texas 75201.

The slurry shall conform to the following requirements for quality and consistency:

a. Slurry when first mixed:

(1) Density shall be not less than 65 pounds per cubic foot measured at the point where fresh slurry is discharged into the trench.

(2) Viscosity shall be not less than 40 seconds when measured by Marsh Funnel.

(3) Water loss shall be not more than 15 cubic centimeters in 30 minutes.

b. Slurry in the trench at time of placing backfill

(1) Density shall be not greater than 75 pounds per cubic foot measured at any depth within the zone where backfill is to be placed.

(2) Water loss shall be not more than 20 cubic centimeters in 30 minutes.

The slurry may be mixed and stored in a slurry pond as shown on the drawings. The slurry shall be transported to the trench by a pipeline or other methods which prevent contamination.

If the density of the slurry in the trench exceeds the specified limits when the trench is otherwise ready for backfill, the slurry shall be cleaned of excess sands and silts before backfilling the trench.

5. MATERIALS

Bentonite for use in the slurry shall be a powdered unadulterated Wyoming sodium bentonite. The properties of the slurry may be altered to suit construction conditions by admixtures used for the control of oil field drilling mud.

Under no conditions will peptizing or bulking agents be allowed.

6. TRENCH EXCAVATION

A rolled-filled cutoff trench, excavated and backfilled by conventional methods, shall first be constructed along the slurry trench centerline as shown on the drawings. The slurry trench shall then be excavated through the rolled-fill cutoff trench. The top of the slurry trench excavation shall be the foundation excavation line as shown on the drawings. The bottom of the slurry trench excavation shall be the bedrock contact line as shown on the drawings or as otherwise directed by the Engineer.

Slurry trench excavation shall proceed in one direction from the point of beginning to the finish. Excavation shall extend to bedrock at the point of beginning and the cut to bedrock shall be maintained continuous along the trench line.

Material excavated from the slurry trench shall be wasted in the disposal area shown on the drawings. Immediately after excavation, the material may be temporarily side cast to allow free slurry to drain back into the trench.

7. PROBING AND CLEANING THE TRENCH BOTTOM

When excavation has uncovered a portion of the trench bottom, the bottom surface shall be cleaned of cobbles and sediments and probed to find areas of weathering, potholes, cracks and crevices. Such areas shall be cleaned to the satisfaction of the Engineer before backfilling the trench.

Sands and other sediments that settle out of the slurry shall be removed from the trench bottom immediately before backfilling the trench. The distance between the toe of the backfill slope and the toe of the excavated slope shall not exceed fifty (50) feet so that large cobbles not removed from the trench bottom by pumping can be removed by the trench excavating equipment.

8. MIXING AND BLENDING BACKFILL MATERIALS

Backfill materials shall consist entirely of borrow materials from the source and meeting the gradation requirements specified for Earth Fill, Zone I, Specification 5A, and shall be thoroughly mixed with bentonite slurry so that all particles are completely coated with the slurry.

The backfill shall be mixed with bentonite slurry in the area adjacent to the trench by windrowing, dozing, blading or by other approved methods. The slurry shall be sluiced or pumped to the mixing areas. The mixed backfill shall have the consistency and appearance of fresh concrete, and shall have a slump ranging between four (4) and eight (8) inches when tested according to conventional concrete slump test methods.

All backfill material shall be mixed with slurry, and the mixture controlled so that during all backfill placement operations the in-place fill slope shall be not steeper than seven horizontal to one vertical. Slurry for mixing with the backfill may be pumped directly from the slurry trench.

9. BACKFILL

Free dropping of backfill material into the trench will not be permitted.

Initially, backfill shall be placed on the bottom of the trench with a tremie pipe. The first lift shall be placed by lowering the backfill material to bedrock. Subsequent lifts shall be built up, using the tremie pipe to place mixed backfill material on the preceding lift, until the backfill reaches the top of the trench with a slope not steeper than seven to one (7:1).

When the control slope (not steeper than 7:1) is established as specified and shown on the drawings, the remaining backfill shall be placed either by tremie pipe or bulldozing the fill materials into the trench. When bulldozing backfill materials into the trench, the bulldozer shall work so that all materials enter the trench on the established slope of the in-place backfill and move down this slope.

As backfilling progresses, the completed portion of the trench shall be covered with uncompacted Zone I material, as shown on the drawings.

10. EXCESS SLURRY AND CLEAN-UP

Excess or waste slurry remaining after completion of the slurry trench shall be wasted in the pond area shown on the drawings.

Slurry that cannot be pumped or hauled to the designated disposal area shall be spread in the backfill mixing area, mixed with Zone I fill material and compacted as part of the core zone blanket fill.

All litter and debris resulting from slurry mixing, handling and from slurry trench construction shall be disposed of by burning, burying or removed from the site to areas approved in writing by the Contracting Officer.

11. MEASUREMENT AND PAYMENT

The slurry trench will be measured to the nearest square foot. Area boundaries shall be the top of the slurry trench and the bedrock contact determined by probing the trench bottom at 20 foot intervals along the centerline. The 20 foot intervals will be measured along the top surface of the slurry trench cutoff. Depths to bedrock will be determined immediately before backfilling the trench. The area for payment will be the sum of areas computed by the average of two adjacent depth measurements multiplied by the distance between the adjacent depth measurements.

Payment will be made at the contract unit price. Such payment will constitute full compensation for all labor, equipment and materials required to excavate and backfill the slurry trench as specified, including the equipment and personnel required to make the depth measurements.

Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 12 of this specification.

Payment for this item does not include excavating and backfilling the five feet deep by twenty feet wide, rolled fill cutoff trench as shown on the drawings. Payment for excavating and backfilling this trench will be included in the respective items of work included in Specifications 4A, Excavation and 5A, Earth Fill.

12. ITEMS OF WORK AND CONSTRUCTION DETAILS

Items of work to be performed in conformance with this specification and the construction details are:

a. Bid Item 46, Slurry Trench Cutoff

(1) This item shall consist of excavating and backfilling the slurry trench within the limits shown on sheets 5 and 7 of the drawings or as directed by the Engineer.

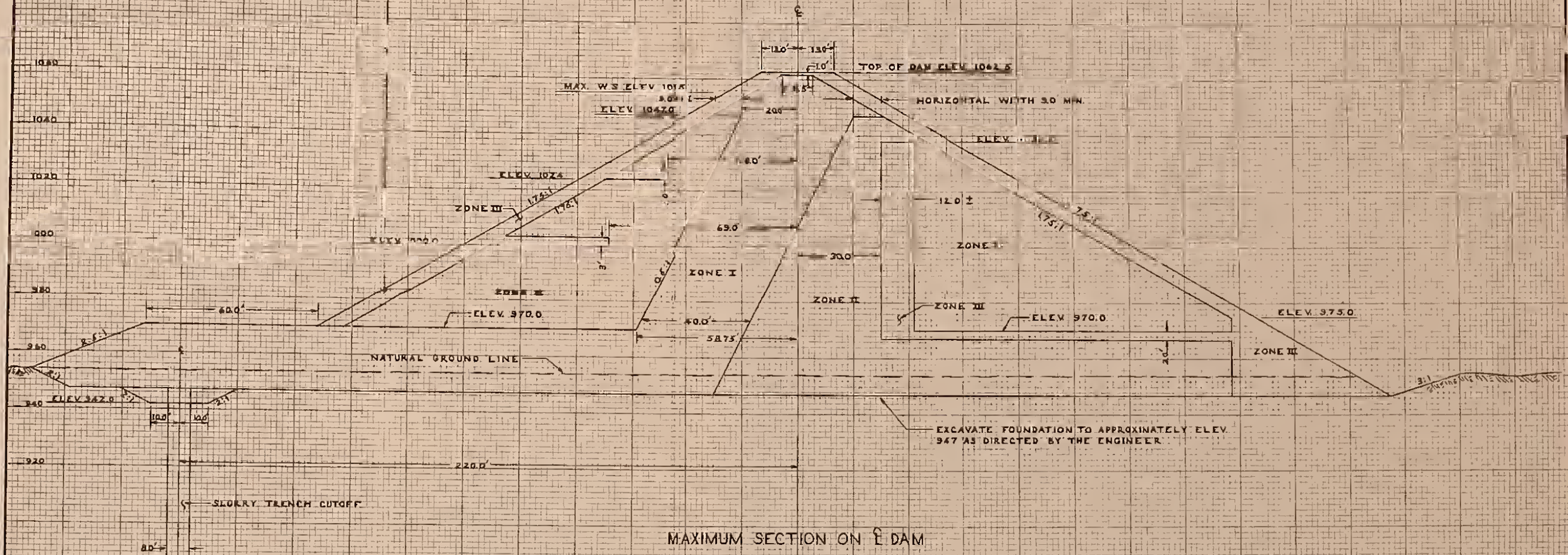
(2) The slurry trench shall be excavated to a minimum width of eight (8) feet.

(3) Excavation and backfilling operations shall proceed in the direction and manner shown on Sheet 7 of the drawings unless the Contractor submits an alternate plan to the Contracting Officer for consideration at least ten (10) days before excavation operations begin.

(4) Backfill material in the slurry trench shall be allowed to settle for at least two (2) weeks before being covered with compacted earth fill for the permanent embankment. After this two (2) week period settlement, cavities in the surface of the slurry trench cutoff shall be filled to the top elevation of the slurry trench cutoff shown on the drawings. Material for filling the settlement cavities shall meet the gradation, moisture and layer thickness requirement for earth fill, Zone I, Specification 5A, Earth Fill. Compaction of the fill in the settlement cavities shall be Class X in conformance with Specification 5A, Earth Fill.

(5) Placement of frozen backfill materials in the slurry trench cutoff will not be permitted.

(6) Measurement and payment will be as specified in Section 11 of this specification. Payment includes compensation for all operations required to place and subsequently process the uncompacted mound of Zone I fill placed over completed portions of the slurry trench cutoff.



MAXIMUM CROSS SECTION
MILL SITE DAM
FERRON WATERSHED
EMERY & SANPETE COUNTIES, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.E. HESS	Date 12-68	Approved by GEORGE LAWRENCE	
Drawn A. J.	8-70	Title STATE CONSERVA	
Traced		Title	
Checked J.E. HANSON	8-70	Sheet No. of	Drawing No.

SCS-ENG-315 Rev. 8-69

Note:
1. Observation wells are for use by the contracting organization. The contractor must include open pipe piezometers or other provisions for measuring ground water elevations across the foundation of the dam in his proposed dewatering plan required in construction specification 25, Removal of Water.
2. The plan of the cutoff trench and the slurry trench are based on the rock line as shown on sheet 3. Stationed points are approximate and will change as conditions revealed by excavation dictate.

FOUNDATION EXCAVATION PLAN

SCALE 200 0 400 IN FEET

℄ CUTOFF TRENCH
PI STA 37+37.40
CURVE DATA
Δ = 47°39'21"
R = 90.57'
T = 40.00'
L = 75.33'

TYPICAL ROCK SURFACE TREATMENTS

CRACKS

FISSURES

SURFACE IRREGULARITIES

PIEZOMETER TUBE INSTALLATION DETAIL

Note: At sta 26+00 only one tube is required.

PI STA 15+84.99
CURVE DATA
Δ = 26°00'
R = 50.0'
T = 11.54'
L = 22.69'

PI STA 18+46.88
CURVE DATA
Δ = 41°00'
R = 50.0'
T = 18.69'
L = 35.78'

PI STA 28+67.28
CURVE DATA
Δ = 49°04'23"
R = 87.62'
T = 40.00'
L = 75.04'

PI STA 30+91.29
CURVE DATA
Δ = 47°21'17"
R = 91.22'
T = 40.0'
L = 75.39'

Note: Bottom width of cutoff trench varies depending on actual depth of excavation. Min. width = 30'.

See typical cross section in slurry trench construction details on this sheet.

CUTOFF TRENCH ℄ LAYOUT

SCALE 50 0 100 IN FEET

Place min 2.0' thick uncompacted, temporary zone I fill over backfilled slurry trench within 4 hrs after backfilling

Step 1 - Excavate cutoff trench to elev 942.0.
Step 2 - Backfill cutoff trench to elev 947.0, with zone I fill.
Step 3 - Excavate and backfill slurry trench - 8.0' wide (min).
Step 4 - Cover slurry trench with temp compacted zone I fill

SLURRY TRENCH CONSTRUCTION DETAILS

SCALE 80 0 20 40 FEET

ELEV \ STA	9+75	12+75
A	943.0	943.0
B	905.0	915.0
C	870.0	886.0

OBSERVATION WELL & PIEZOMETER INSTALLATION DETAILS
STA 9+75 & 12+75 ℄ OF DAM

SCALE 20 0 20 IN FEET

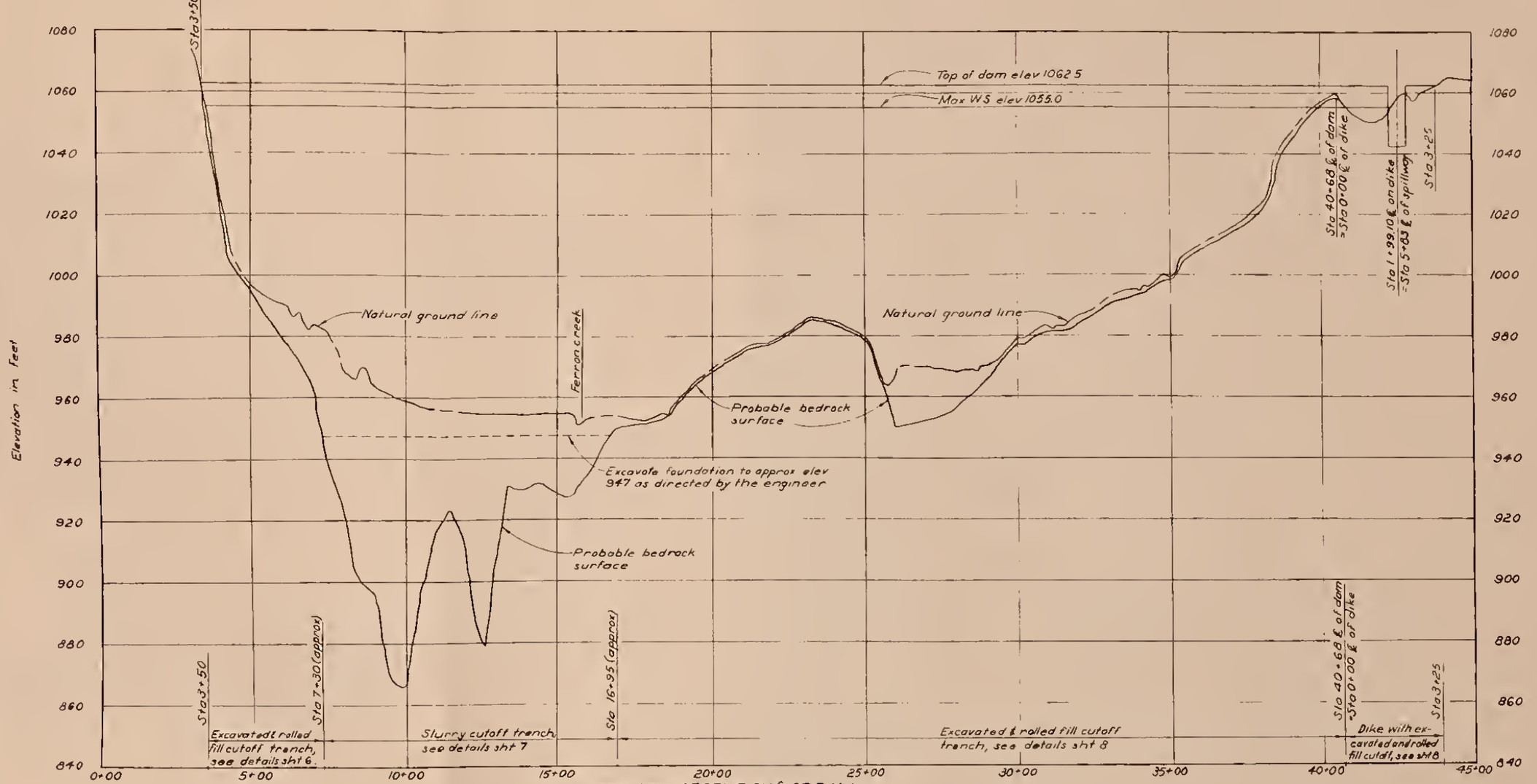
PIEZOMETER INSTALLATION DETAILS
(STA 26+00 ℄ DAM)

SCALE 20 10 0 40 IN FEET

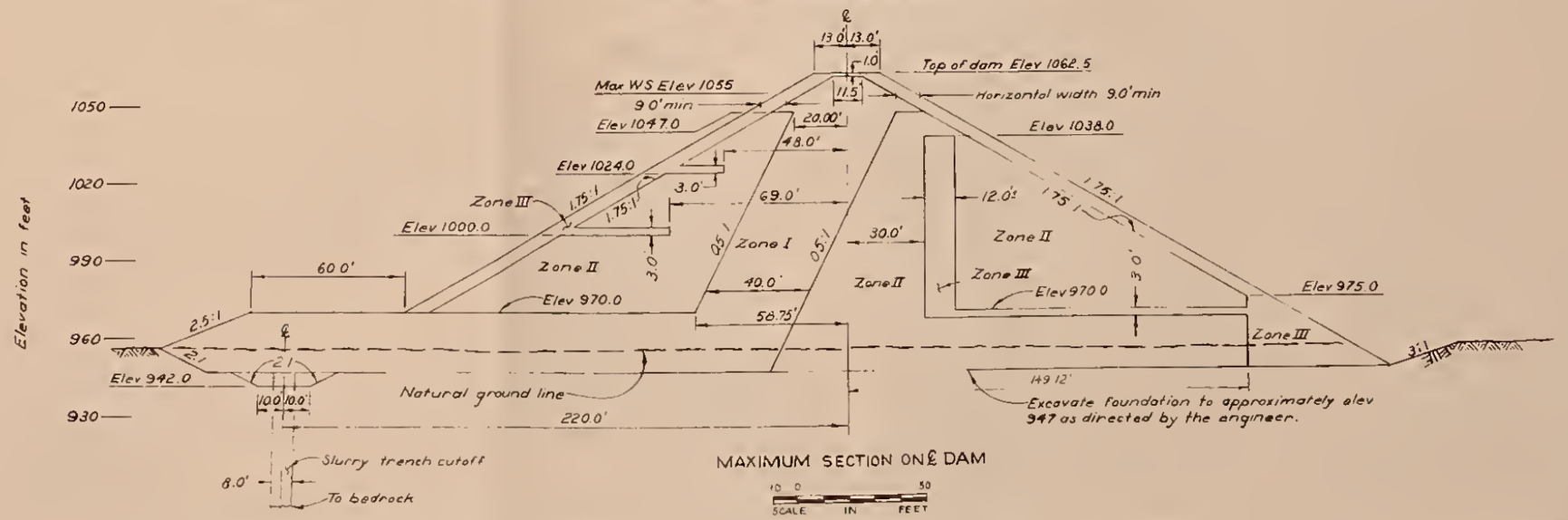
FOUNDATION EXCAVATION PLAN
MILLSITE DAM
FERRON WPP
EMERY & SANPETE COUNTIES, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed M.E. Hess 12-68
Drawn L.W. McClintock 12-68
Traced
Checked WPO GPS 2-69
Approved by G. LAWRENCE, Title STATE CONS. ENGR.
Sheet No. 5 of 38
Drawing No. 7-E-18915



GEOLOGIC PROFILE ON ℄ OF DAM



MAXIMUM SECTION ON ℄ DAM

GEOLOGICAL PROFILE ON ℄ OF DAM & MAXIMUM CROSS SECTION

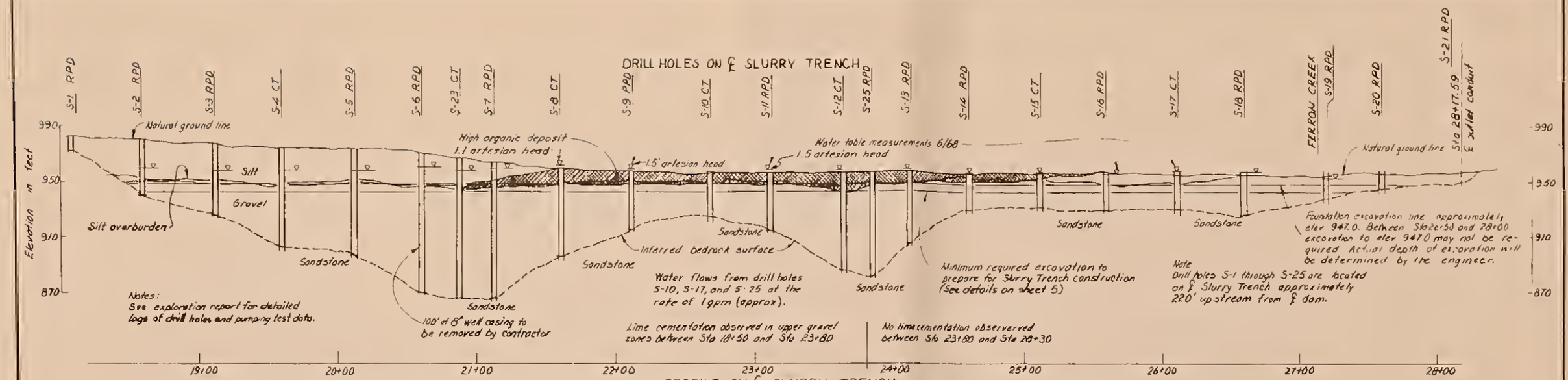
MILLSITE DAM

FERRON WPP

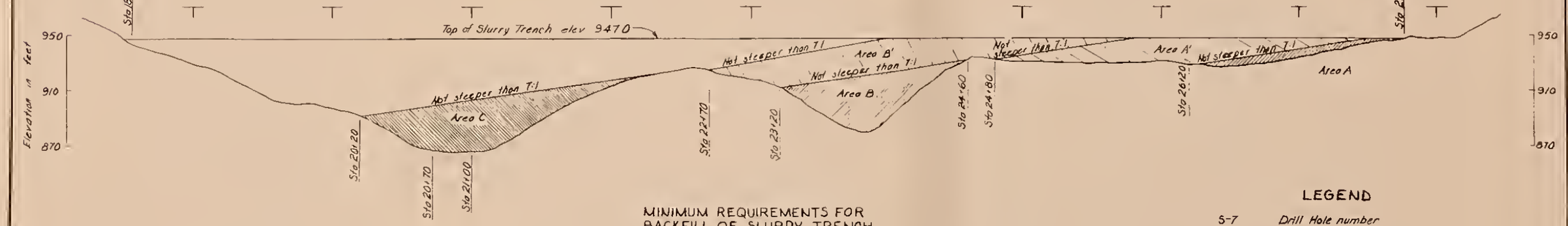
EMERY & SANPETE COUNTIES, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

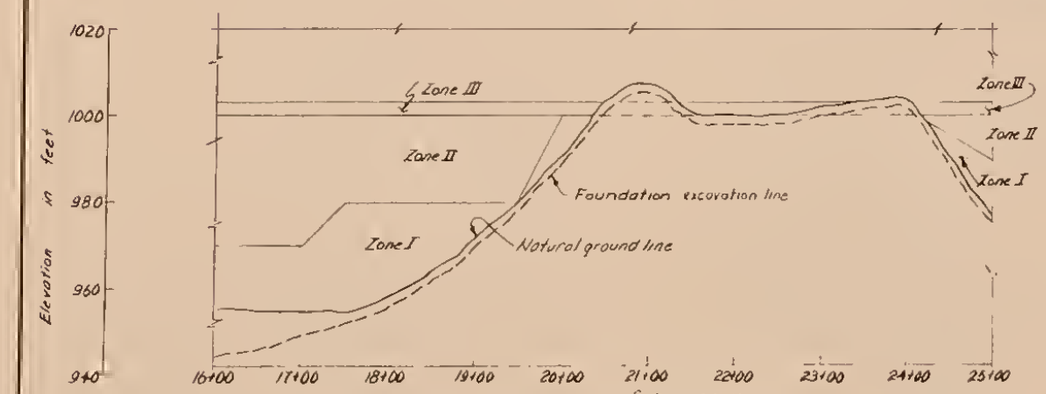
Designed M.E. Hess	Date 12-68	Approved by G. LAWRENCE	
Drawn D.C. Anderson	12-68	Title STATE CONS. ENGR.	
Traced		Title	
Checked WPO GPS	2-69	Sheet No 3 of 38	Drawing No 7-E-18915



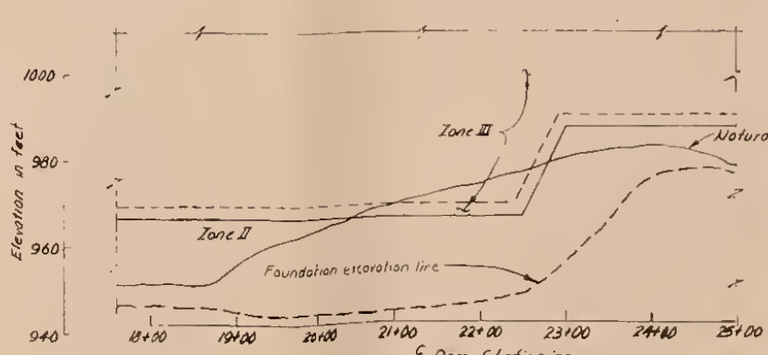
1. Details shown are based on beginning Slurry Trench excavation and backfill at Sta 27+76 (approx) and proceeding to finish at Sta 18+56 (approx).
2. Placement of backfill in areas A, B & C shall be by tremie pipe methods.
3. The toe of the backfill slope shall not advance beyond Sta 24+80 until area B has been backfilled.
4. The toe of the backfill slope shall not advance beyond Sta 22+70 until area C has been backfilled.
5. At contractor's option areas greater than those shown for A, B and C may be filled by tremie pipe methods.
6. Backfill slopes greater than 7:1 will not be permitted.



MINIMUM REQUIREMENTS FOR BACKFILL OF SLURRY TRENCH



PROFILE ℞ A
100 ft U.S from ℄ Dam
(See sht 9)



PROFILE ℞ B
30 ft D.S from ℄ Dam
(See sht 9)

LEGEND

S-7	Drill Hole number
RPD	Rotary Penn Drill
CT	Cable Tool drill
Silt	Sandy silt deposit
Gravel	Stratified, cemented deposit of silty, sandy cobbles and gravels
Organic	Soft, sandy silt with high organic content
▽	Water table measurements 6-68

SLURRY TRENCH CONSTRUCTION DETAILS
MILLSITE DAM
FERRON W.P.P.
EMERY & SANPETE COUNTIES, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	ME Hess	Date 6-69	Approved by G. LAWRENCE
Drawn	SJ Heileson	12-69	Title STATE CONSENGR
Traced			Project No. 7
Checked	WPO GPS	2-69	Sheet No. of 38

Drawing No. 7-E-18915

Fig. 4

18+00 19+00 20+00 21+00 22+00 23+00 24+00 25+00 26+00 27+00

340

320

FOUNDATION EXCAVATION LINE

CUTOFF TRENCH EXCAVATION LINE

ACTUAL EXCAVATION PAYLINE

PROPOSED EXCAVATION LINE

SLURRY TRENCH CENTERLINE PROFILE
MILL SITE DAM
FERRON WATERSHED
EMERY & SANPETE COUNTIES, UTAH

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date		
Designed		Approved by	J.E. HANSON
Drawn	A.S. 8-70	Title	PROJECT ENGR.
Traced		Title	
Checked	J.E. HANSON 8-70	Sheet No. of	Drawing No.

SCS-ENG-115 Rev. 8-69

Photo 1: Continuous samples taken by the cable tool drill at hole 23. Sample depths 58 to 68 feet.

SCS PHOTO 8-1477-1

Photo 2: Continuous samples taken by the cable tool drill at hole 23. Sample depths 69 to 74 feet.

SCS PHOTO 8-1477-2

Photo 3: Beginning excavation of slurry trench with the dragline.

SCS PHOTO 8-1594-9

Photo 4: Fresh Slurry being pumped into the Slurry trench. Note: cracking of soil along the bank edges. After the trench was filled with slurry, the only sloughing of the banks was at the point the slurry ran back into the trench from the spoil pile.

SCS PHOTO 8-1594-12

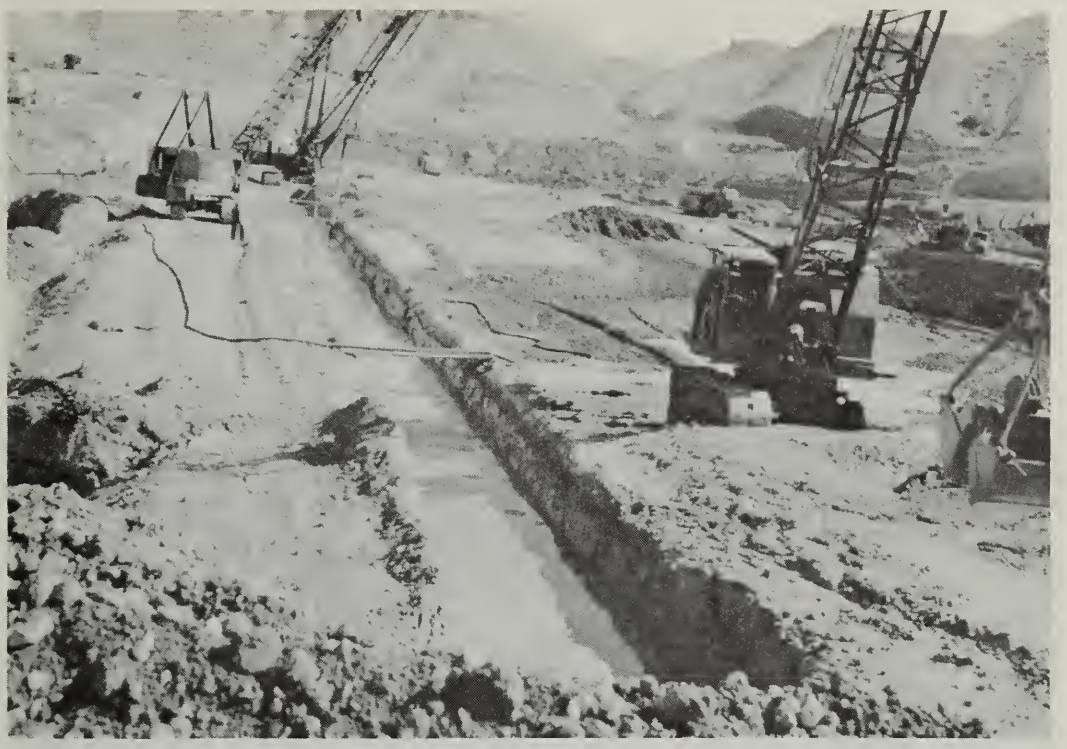


Photo 5: Dragline with a clamshell is starting backfill of the slurry trench. Cleaning of the bedrock is being done with the blow tube. Excavation of the trench is taken place with the large dragline.

SCS PHOTO 8-1609-3

Photo 6: Ripper used to rip the bottom of the slurry trench.

SCS PHOTO 8-1619-7

Photo 7: Dragline bucket used in excavation of the slurry trench.

SCS PHOTO 8-1620-2

Photo 8: Material excavated from the slurry trench.

SCS PHOTO 8-1620-4

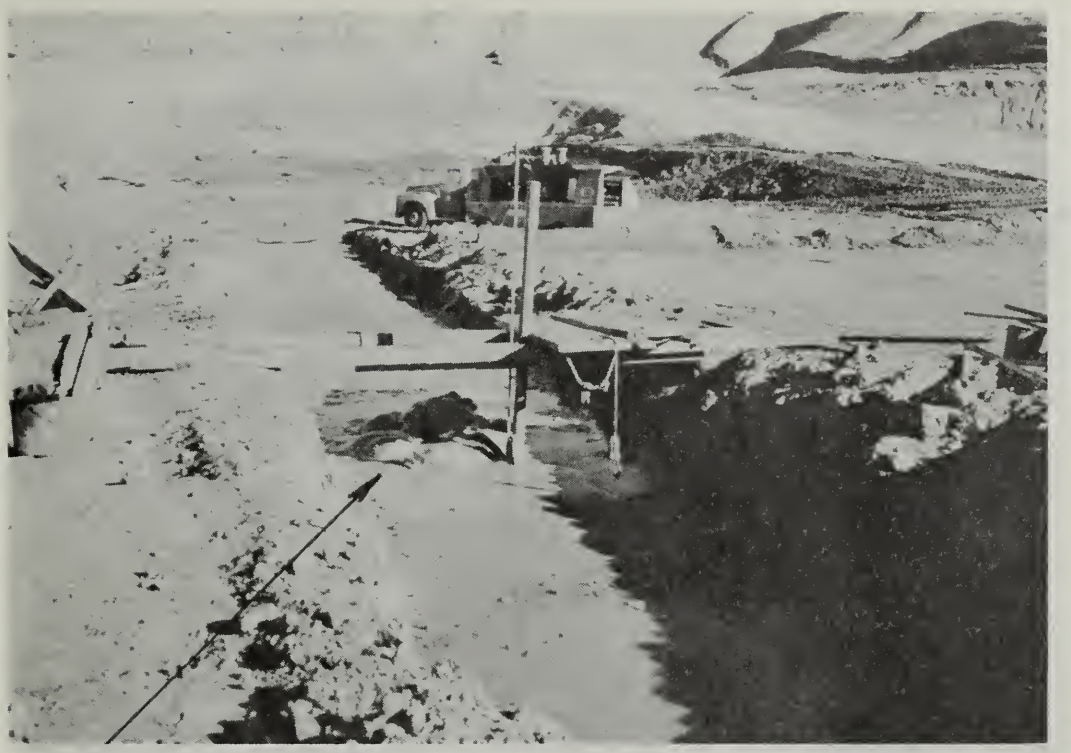


Photo 9: Extent of disturbance at surface of slurry due to blasing in gravels at the bottom of the trench.

SCS PHOTO 8-1619-9

Photo 10: De-sanding of the slurry to lower density.

SCS PHOTO 8-1619-14

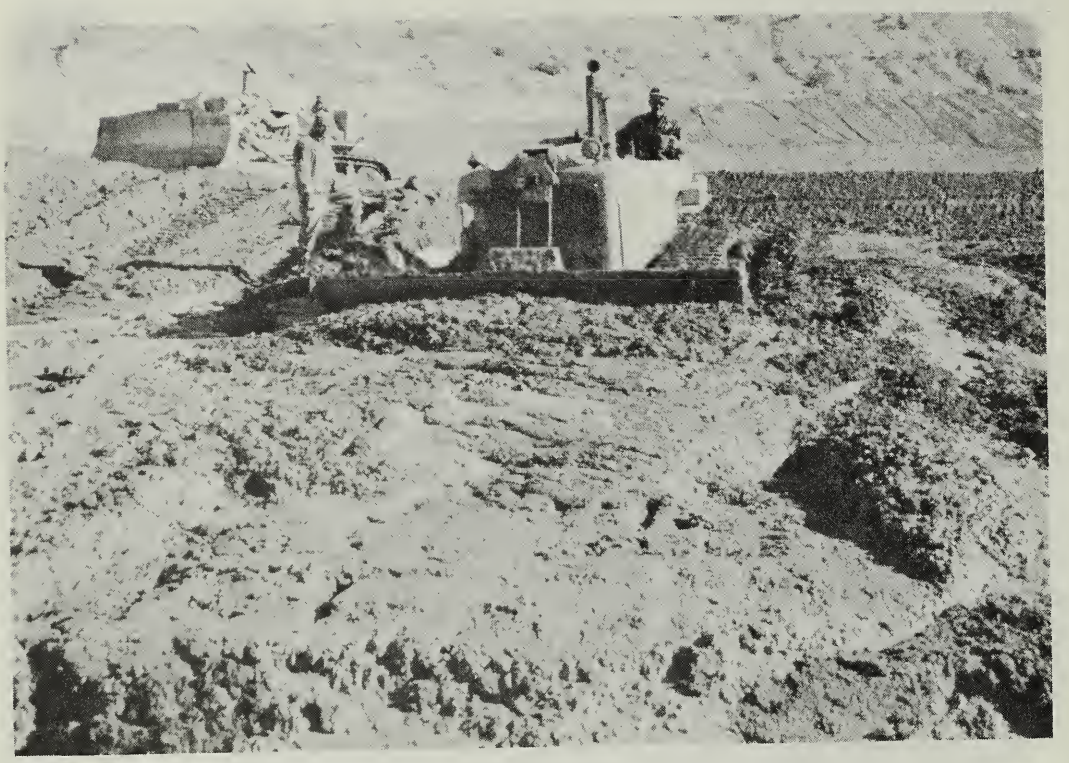


Photo 11: Mixing of slurry trench backfill material.

SCS PHOTO 8-1619-4

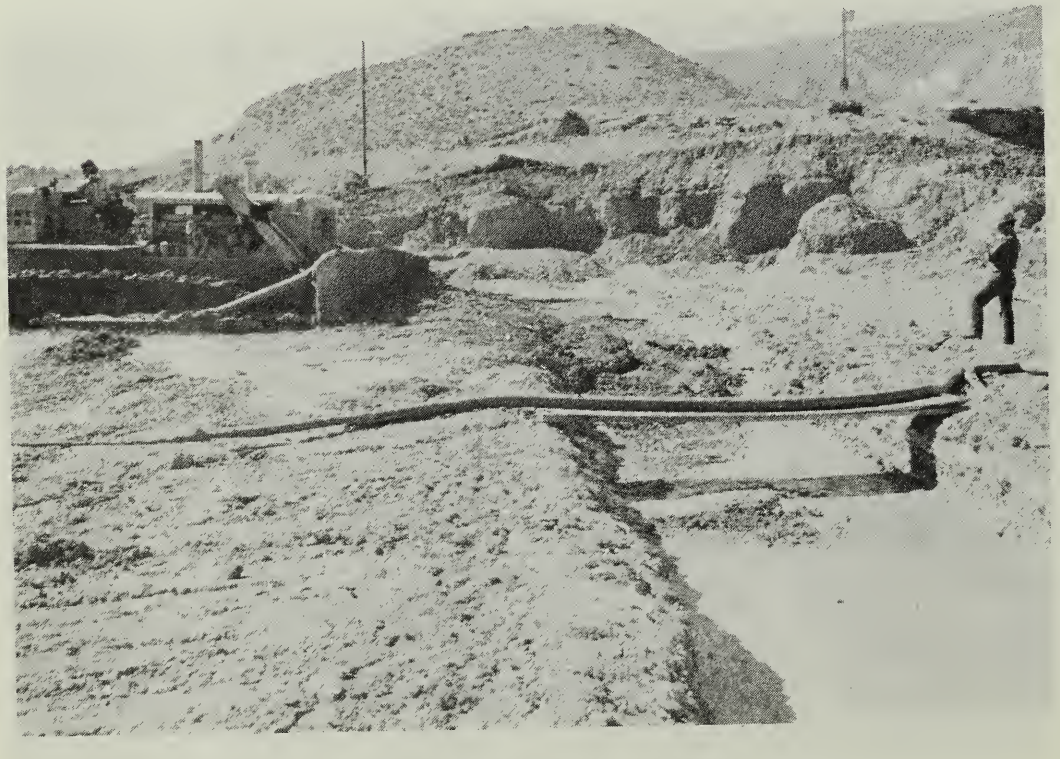


Photo 12: A D-8 Cat backfilling slurry trench.

SCS PHOTO 8-1608-4

Photo 13: The Lima Dragline starting re-excavation of the slurry trench in the South gorge.

SCS PHOTO 8-1619-3

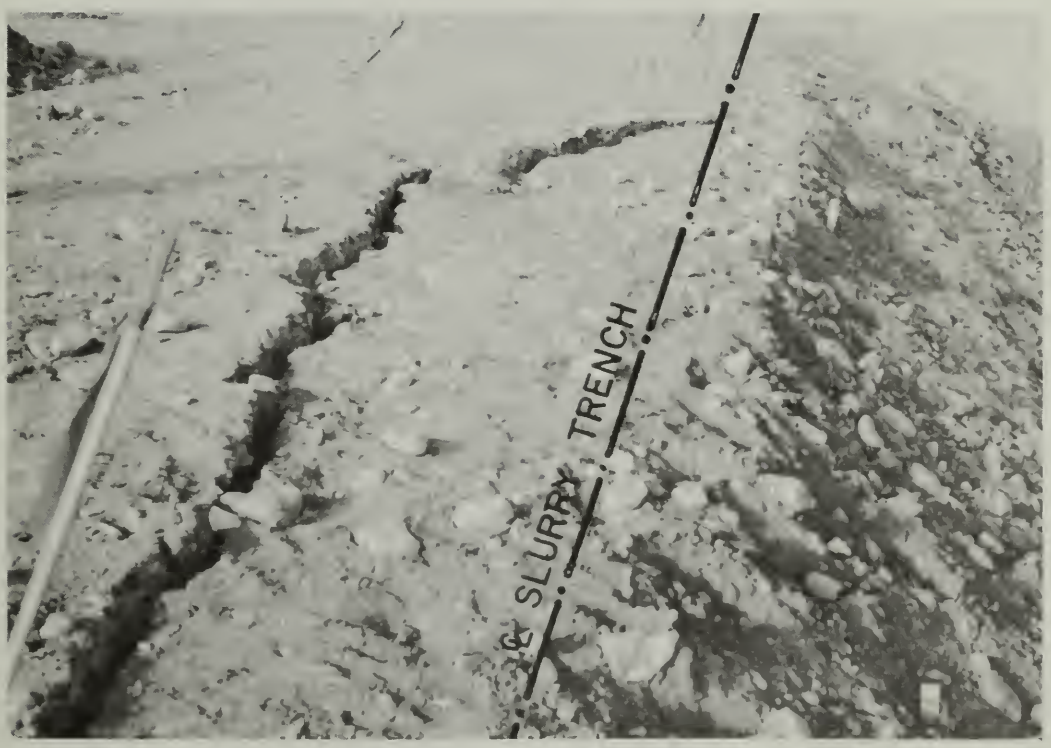


Photo 14: Settlement cracks over the slurry trench after the winter shut down.

SCS PHOTO 8-1640-16

Photo 15: Settlement hole over the South gorge of the slurry trench after the winter shut down.

SCS PHOTO 8-1642-3

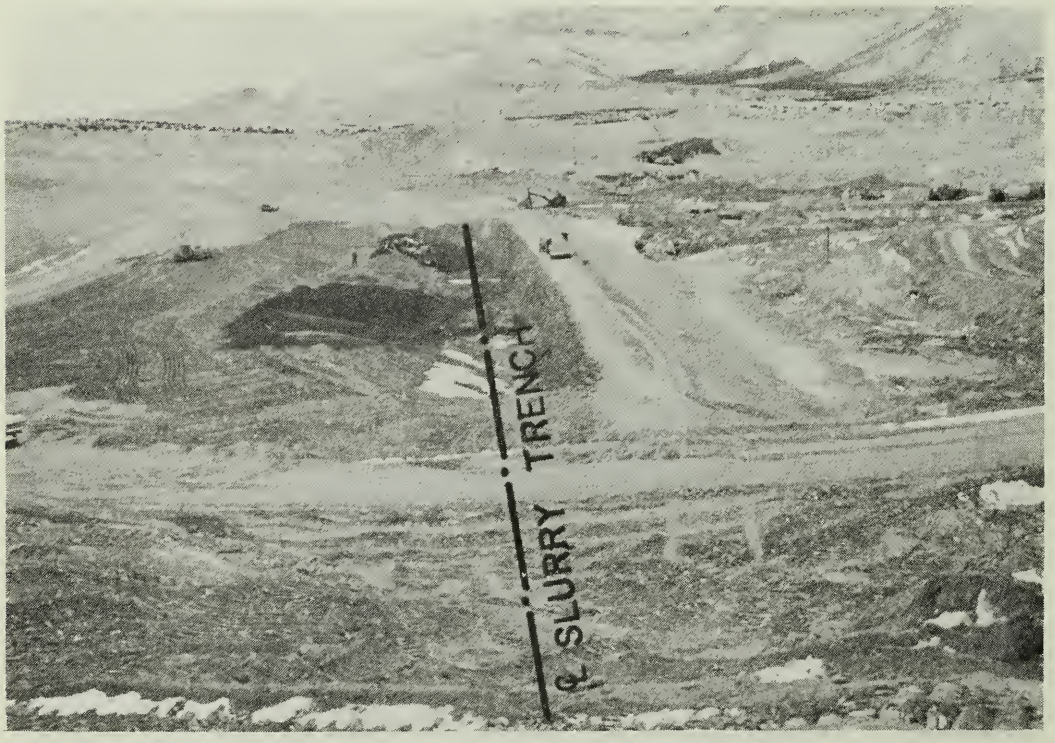


Photo 16: Excavation of the Zone I blanket over the slurry trench after settlement had taken place.

SCS PHOTO 8-1642-8